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(54) Magnetic recording medium

(57) A magnetic recording medium such as a telephone card in which visible patterns can be written includes a heat sensitive layer (6) formed on a magnetic recording layer (4) and a thin metallic layer (8) formed on the heat sensitive layer (6). The thin metallic layer (8) of the magnetic recording medium preferably has a rough surface provided by including minute particles in the heat sensitive layer (6). In using said magnetic recording medium, information corresponding to at least a part of the information recorded in the magnetic recording layer can be written as a visible pattern by selectively removing the thin metallic layer (8). Typically the thin material is ablated using a laser.

FIG.1

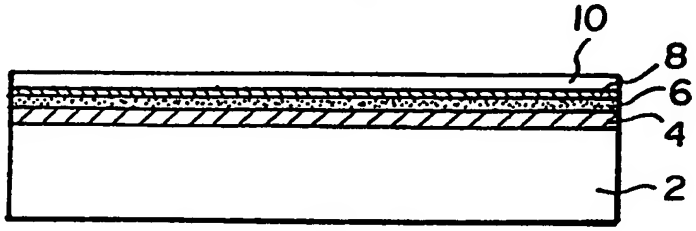

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FIG.1

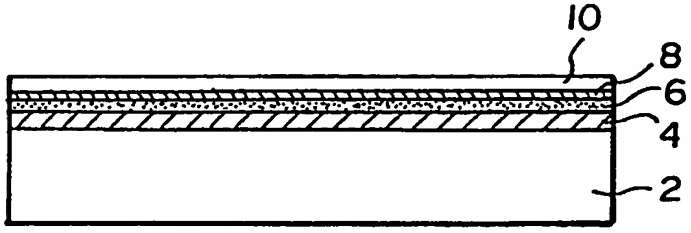

FIG.2(a)

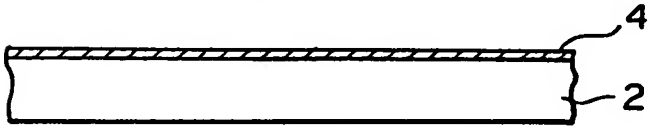

FIG.2(b)

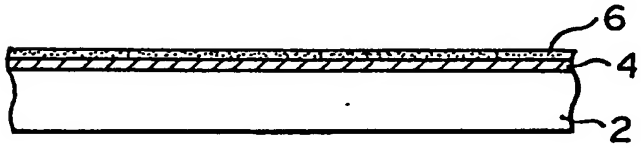

FIG.2(c)

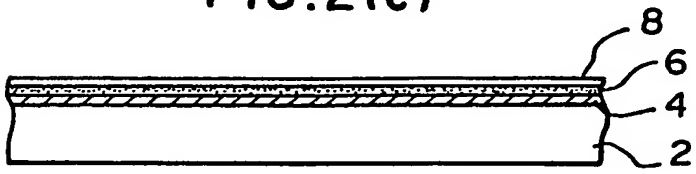

FIG.2(d)

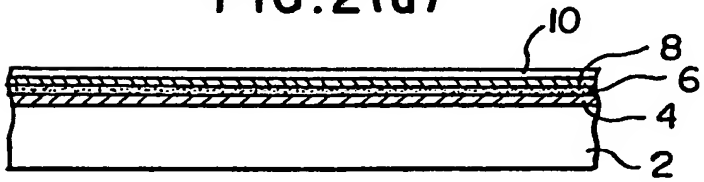

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FIG.3

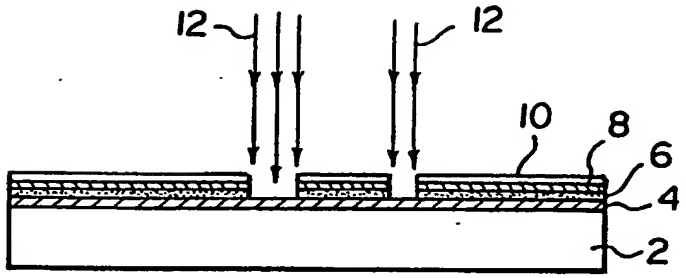

FIG.4

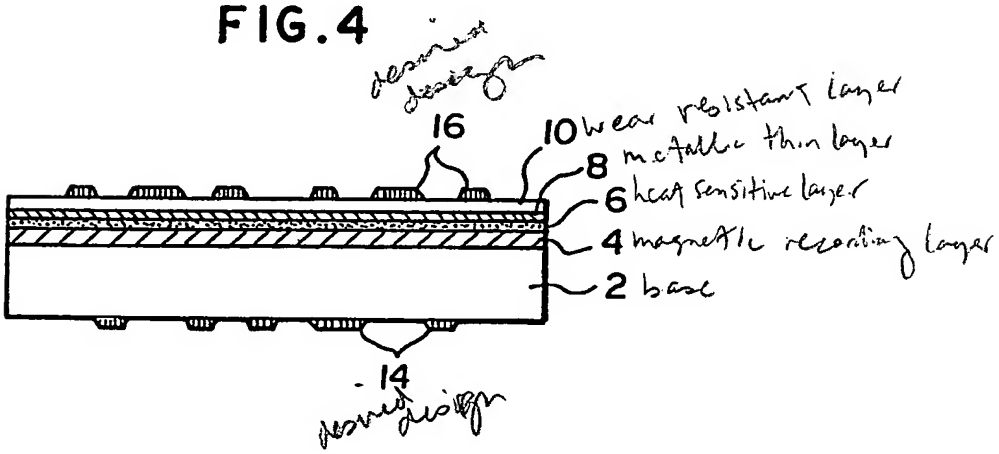

FIG.5

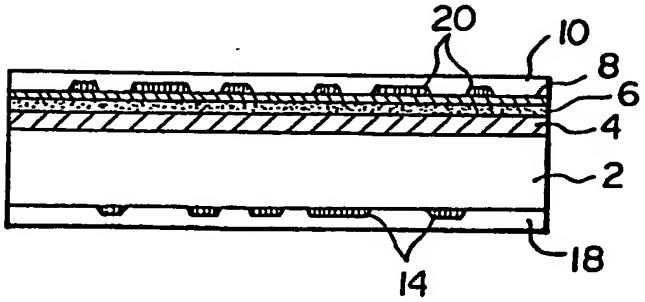

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FIG.6(a)

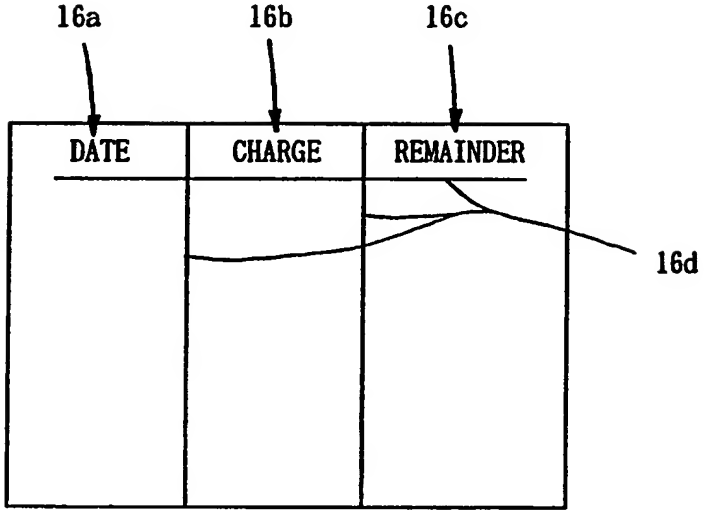
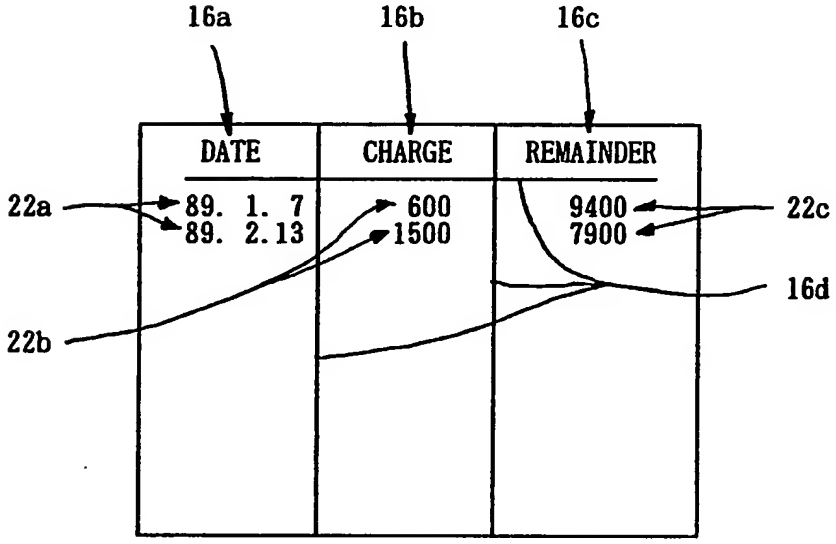


FIG.6(b)



Magnetic Recording Medium, Its Production Method and Use

This invention relates to a magnetic recording medium, and specifically to a magnetic recording medium on the surface of which visible patterns (information) can be written, its production method and its use.

This invention can be effectively applied to magnetic cards including prepaid cards such as a telephone card wherein figures and the like corresponding to the contents of magnetic recording are printed to enable the magnetically recorded contents of said recording medium to be observed directly by eye.

Magnetic cards are handy to carry and are widely used as useful cards. They have a magnetic recording layer formed on a desired area of the surface of a card base with proper thickness.

Magnetically recorded information such as the frequency of use and their remaining value cannot be seen in the magnetic card and therefore, in the past the remaining value is indicated by punching holes in a prepaid magnetic card. However, since the precise remainder is not indicated, cash or another magnetic card must be used when the remaining value is insufficient. It is sometimes required to print the frequency of use, the remaining value and the like on the card surface in order to avoid such a situation.

Conventionally, printing is generally performed on the surface of a magnetic card opposite to its magnetic recording layer by a wire dot print head through a pressure sensitive ink ribbon, by a thermal print head through a heat sensitive ink ribbon or by applying a thermal print head to a heat sensitive recording layer formed on the card surface. However, a desired design is generally printed on the surface of the magnetic card opposite to its magnetic recording layer and a wide area

for the above printing is not desirable in terms of the aesthetic appeal of the design.

Printing is also performed on the side of the magnetic recording layer of the magnetic card in some cases and in such cases the magnetic recording layer is partially formed on the card base and printing is performed on an area different from said recording layer. Therefore, it is impossible to make both the magnetic recording area and the printing area sufficiently large.

When a heat sensitive recording layer is formed on the card surface, since the recording layer is deteriorated (changes with the passing of time) by the accumulation of external heat energy, the contents of recording (visible patterns) are hard to see and recording is difficult.

Recently, magnetic cards wherein a larger amount of information is recorded have come to be used and therefore it is desirable that both the magnetic recording area be large and the prting area be as large as possible. Furthermore, since it is desirable that printed letters be as lare as possible to enable easy reading, it is preferable that the printing area be as large as possible from this point of view as well.

According to a first aspect of this invention a magnetic recording medium in which visible patterns can be written, includes a heat sensitive layer formed on a magnetic recording layer and a thin metallic layer formed on the heat sensitive layer.

According to a second aspect of this invention a method for producing a magnetic recording medium is characterised by using a material containing minute particles to form a roughed heat sensitive layer on a magnetic recording layer and depositing a thin metallic layer on the heat sensitive layer.

According to a third aspect of this invention a method of using a magnetic recording medium according to the first aspect of this invention or made in accordance with the second aspect of this invention is characterised by writing information by selectively removing the thin metallic layer to provide a visible pattern on the surface of the magnetic recording medium.

An advantage of this invention is the provision of a magnetic recording medium wherein visible patterns (information) including letters, marks and figures can be written on a magnetic recording layer and the provision of a visible pattern (information) area which does not change with the passing of time.

Examples of a recording medium and method in accordance with this invention will now be described with reference to the accompanying drawings, in which:-

Figures 1, 4 and 5 are rough cross-sectional views of the main parts of magnetic recording media of this invention;

Figures 2(a) to (d) indicate the production processes for the magnetic recording medium of this invention;

Figure 3 is a rough cross-sectional view for explaining a method for writing patterns in the magnetic recording medium of this invention; and

Figures 6(a) and (b) are plan views for explaining the formation of indications produced by writing visible patterns in the magnetic recording medium of this invention.

Examples of this invention will be explained while referring to the drawings in the following.

Figure 1 is a rough cross-sectional view of the main part of a magnetic card which is an example of the magnetic recording medium of this invention.

In Fig. 1, a magnetic recording layer 4 is formed on the entire surface (upper surface) of a base 2, a heat sensitive layer 6 is formed on said magnetic recording layer, a metallic thin layer 8 is formed on said heat sensitive layer and a wear-resistant layer 10 is formed on said metallic thin layer.

For the above base 2, synthetic paper, sheets of synthetic resins such as polyethylene terephthalates, epoxy resins, polyvinyl chlorides and polycarbonates and similar materials can be used.

For the above magnetic recording layer 4, those conventionally used as a magnetic recording layer in this type of magnetic recording medium can be used. For example, Ba-ferrite, Sr-ferrite, Co-coated γ-Fe_2O_3, γ-Fe_2O_3, needle-like iron powder or CrO_2 with particle size of 10 μm or less preferably 0.01 ~ 5 μm can be used as a magnetic material and a commonly used polyester, alkyd, vinyl or polyurethane resin or a mixture of at least two of these resins can be used as a binder resin. The ratio of the binder resin to the magnetic material is properly set by considering adhesiveness to the base, paint film strength, voltage detected by a magnetic head, and the like. The ratio by weight of the binder resin to the magnetic material can be in the range of 1/1 ~ 1/10 for example and is preferably 1/2 ~ 1/8. The thickness of said magnetic recording layer 4 is about 10 ~ 15 μm for example.

The above heat sensitive layer 6 is provided in order to improve the writing and recording characteristics of the

metallic thin layer 8 (sensitization effect). For a heat sensitive material used to form the heat sensitive layer 6, self-oxidization resins such as nitrocellulose resins as well as thermoplastic resins such as acrylic resins, polyester resins, polyvinylchloride resins, vinyl acetate resins, polystyrene resins and polybutyral resins can be used. The thickness of said heat sensitive layer 6 is 10 μm or less for example and preferably about 0.5 ~ 3 μm.

The above metallic thin layer 8 covers the magnetic recording layer 4 and is used as a writing recording film. For a metallic material used to form the metallic thin layer 8, low melting point metals such as Sn, Bi Se, Te and Zn can be used for example. The thickness of said metallic thin layer 8 is about 50 ~ 5,000 Å for example and preferably about 20 to 100 nm (200 to 1,000 Å).

For the above wear-resistant layer 10, those conventionally used as a wear-resistant layer in this type of magnetic recording medium, for example, cellulose resins, urethane resins, polyester resins, vinyl resins, epoxy resins and acrylic resins can be used. To such a resin, a phthalic acid ester, an ester of fatty acid, an orthophosphoric acid ester or a similar compound can be added as a plasticizer and oleylamide, stearylamide, a silicone or a similar compound can be added to give smoothness. In addition, when the resin is applied as a coating to the metallic thin layer 8, a solvent which does not damage the above metallic thin layer 8 and heat sensitive layer 6 and is

properly selected from solvents such as glycol ethers and alcohols must be used. The amount of the solvent used can be reduced by employing an ultraviolet-ray-cured resin or an electron-ray-cured resin. An acrylic, epoxy, polyester or similar resin can be used as said ultraviolet-ray-cured resin. The thickness of said wear-resistant layer 10 is 10 μm or less for example and preferably about 1 ~ 5 μm.

Figs. 2(a) ~ (d) indicate production processes for such a magnetic card as mentioned above. A production example will be described according to these drawings in the following.

As shown in Fig. 2(a), a magnetic sheet was prepared by forming a magnetic recording layer 4 with 10 μm thickness, 2750 Oe coercive force and 1.4 Mx/cm residual magnetization in which Ba-ferrite was used as the magnetic material on a white polyethylene terephthalate film 1 with 188 μm thickness.

Next, as shown in Fig. 2(b), a heat sensitive layer 6 with 2 μm thickness was formed on the magnetic recording layer 4. Said heat sensitive layer was formed by

Vinylchloride acetate polyester resin	20 pwt
Low molecular weight polyethylene powder	2 pwt
Phthalic acid ester plasticizer	1.5 pwt
Methyl ethyl ketone	40 pwt
Toluene	40 pwt

preparing a coating of the above composition, applying the coating to the magnetic recording layer 4 using a roller coater and then drying the applied coating in an oven at 100°C for

one minute.

Here, the above low molecular weight polyethylene powder is used as minute particles for roughing the surface of the heat sensitive layer 6. That is to say, when said heat sensitive layer has been roughed, a metallic thin layer 8 is easily roughed during its formation in the following process and as the result diffuse reflection by said metallic thin layer is increased, homogeneous white is obtained, the contrast between the metallic thin layer 8 and the magnetic recording layer 4 is improved and visible patterns can be easily seen macroscopically. For this purpose, the surface roughness (Ra in JIS B 0601) of the metallic thin layer 8 is 0.1 ~ 2.0 μm for example and preferably 0.3 ~ 1.0 μm. A polyimide resin powder, a low molecular weight tetrafluoroethylene resin powder, calcium stearate, tin stearate, a polystyrene latex, bentonite, wollastonite, talc, aluminum silicate, sericite, kaolin clay, white carbon, calcium carbonate, chalk, slaked lime, dolomite powder, magnesium carbonate, barium sulfate or a similar substance can also be used as minute particles for roughing the heat sensitive layer 6. The mean particle size of said minute particles is 0.3 ~ 10 μm for example and preferably 0.6 ~ 5.0 μm. Fifty parts by weight or less preferably 20 parts by weight or less of said minute particles are used for 100 parts by weight of the resin.

The above plasticizer is added to increase the sensitivity of the heat sensitive layer 6. A plasticizer compatible with

the resin can be selected from various plasticizers such as phthalic acid derivatives, adipic acid derivatives, maleic acid derivatives and stearic acid derivatives as the plasticizer used for this purpose. It is preferable that 10 parts by weight or less of said plasticizer be used for 100 parts by weight of the resin.

The above heat sensitive layer 6 can also be

Nitrocellulose	20 pwt
Low molecular weight polyethylene powder	2 pwt
Methyl ethyl ketone	40 pwt
Toluene	40 pwt

formed by using a coating of the above composition.

Next, as shown in Fig. 2(c), an Sn thin layer 8 with 500 Å thickness was formed on the heat sensitive layer 6 at a rate of 20 Å/sec. by vacuum evaporation coating. Said Sn thin layer had little metallic luster and was nearly white.

Next, as shown in Fig. 2(d), a wear-resistant layer 10 with 2 μm thickness was formed on the Sn thin layer 8. Said wear-resistant layer was formed by

Silicone-acrylic resin	20 pwt
Silicone oil	0.04 pwt
Ethyl cellosolve	75 pwt
Cellulose acetate	5 pwt

preparing a coating of the above composition, applying the coating to the Sn thin layer 8 using a roller coater and then drying the applied coating in an oven at 120°C for one minute.

Finally, the thus obtained plate was punched into a given shape to obtain a magnetic card.

Fig. 3 is a rough cross-sectional view for explaining a method for writing patterns in the magnetic card of this example mentioned above.

As shown in Fig. 3, when laser beams 12 are irradiated in a desired pattern (a letter for example) from above the wear-resistant layer 10, the heat sensitive layer 6 of the irradiated portion is locally heated, the heat sensitive layer 6, the metallic thin layer 8 and the wear-resistant layer 10 of this portion are removed and the magnetic recording layer 4 is partially exposed. As the result, the nonirradiated portion exhibits a whitish color because its metallic thin layer 8 remains while the irradiated portion exhibits a blackish color of the magnetic recording layer 4. Therefore, a visible pattern (information) is formed in a sufficient contrast.

Such laser beam irradiation can be performed by a laser marker using a carbonic acid gas laser (e.g., LASERMARK System Six manufactured by Lumonics Pacific Company) or a laser marker using Nd:YAG laser (e.g., SL472B manufactured by Nippon Denki Company). Patterns can also be written by heating using a thermal head instead of laser beam irradiation.

Such visible pattern writing as mentioned above is effectively applied to printing records of card usage (dates and charges) and particulars of the remainder in magnetic cards. Specifically, in a magnetic card in which the remainder sum

recorded in the magnetic recording layer is revised every time of its use, the details are printed in the surface of the card to enable the user to always know the contents of the card.

In the above example, the color of the magnetic recording layer is effectively utilized in printing information on the metallic thin layer. Specifically, although the heat sensitive layer may not be completely removed even by heating by laser beam irradiation or a similar means, using a transparent material as the heat sensitive layer enables the color of the magnetic recording layer of the heated portion to be macroscopically seen thereby enabling formation of visible patterns (information).

In this invention, however, it is also possible to use a heat sensitive layer the color of which is in a good contrast with the metallic thin layer and to utilize the color of the heat sensitive layer for the formation of visible patterns (information) by not completely removing the heat sensitive layer of the heated portion by heating during use.

Figs. 4 and 5 are rough cross-sectional views of the main parts of magnetic cards which are examples of magnetic recording medium of this invention. In these drawings, the same members as those shown in Fig. 1 are represented by the same symbols.

In the example shown in Fig. 4, a desired design 14 is printed on the surface of the base 2 opposite to the magnetic recording layer 4, and a desired design 16 is also printed on

the wear-resistant layer 10. The design 16 and visible patterns produced by the above heat writing may synergistically form desired indications.

In the example shown in Fig. 5, a desired design 14 is printed on the surface of the base 2 opposite to the magnetic recording layer 4, and the design 14 is covered by an over coat layer 18. In addition, a desired design 20 is printed on the metallic thin layer 8 and the wear-resistant layer 10 is formed over the design 20. The design 20 has the same effect as the above design 16.

Here, indications formed by the synergistic effect of a printed design and visible patterns produced by the above heat writing will be explained.

Figs. 6(a) and (b) are plan views for explaining how indications are formed by writing visible patterns in a magnetic card which is an example of the magnetic recording medium of this invention.

Fig. 6(a) is an unused magnetic card on the surface of which "DATE" 16a, "CHARGE" 16b, "REMAINDER" 16c and lines 16d are previously formed as the above printed design 16.

Fig. 6(b) indicates a used magnetic card wherein the date of use 22a, the charge 22b and the remainder sum 22c are recorded in given positions corresponding to the above printed designs 16a, 16b and 16c by such visible pattern writing as explained according to Fig. 3.

In the magnetic recording medium of this invention, it is

also possible to perform the above conventional visible pattern writing on the surface of the base 2 opposite to the magnetic recording layer 4.

According to this invention mentioned above in which a heat sensitive layer is formed on a magnetic recording layer and a metallic thin layer is formed on the heat sensitive layer, visible patterns such as letters, marks, and figures can be written on the magnetic recording layer and therefore both the magnetic recording area and the visible pattern writing area can be sufficiently large.

CLAIMS

1. A magnetic recording medium in which visible patterns can be written, including a heat sensitive layer formed on a magnetic recording layer and a thin metallic layer formed on the heat sensitive layer.

2. A magnetic recording medium according to claim 1, wherein the thin metallic layer has a rough surface.

3. A magnetic recording medium according to claim 1 or 2, in which a colour contrast exists between the magnetic recording layer and the thin metallic layer and in which visible patterns are formed by selectively removing the thin metallic layer.

4. A magnetic recording medium according to any preceding claim, in which a previously printed layer over lies the thin metallic layer, and in which the markings in the previously printed layer provide a synergistic impression when considered in conjunction with the visible patterns.

5. A method for producing a magnetic recording medium characterised by using a material containing minute particles to form a roughed heat sensitive layer on a magnetic recording layer and depositing a thin metallic layer on the heat sensitive layer.

6. A method of using the magnetic recording medium according to claim 1 or made by a method according to claim 5, which is characterised by writing information by selectively removing the thin metallic layer to provide a visible pattern on the surface of the magnetic recording medium.

7. A method of using a magnetic recording medium according to claim 6, wherein the magnetic recording medium also includes a previous layer having a design forming a part of a required indiciation, and wherein the visible patterns produced by selective removal of their

metallic layer produce a synergistic effect with the previously printed layer.

8. A magnetic recording medium substantially as described with reference to the accompanying drawings.

9. A method of producing or using a magnetic recording medium substantially as described with reference to the accompanying drawings.

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